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PTO/SB/21 (6-98)
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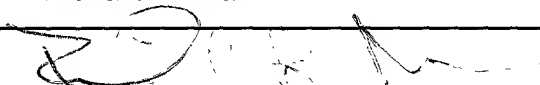
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|---|----------------------|------------------------|------------|
| TRANSMITTAL FORM (to be used for all correspondence after initial filing) | Application Number | | |
| | Filing Date | | |
| | First Named Inventor | Andrew J. Cleveland | |
| | Group Art Unit | | |
| | Examiner Name | | |
| Total Number of Pages in This Submission | 26 | Attorney Docket Number | MLF-600-09 |

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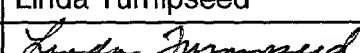
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| Firm or Individual name | Richard B. Main |
| Signature |  |
| Date | 10/12/2000 |

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FEE TRANSMITTAL

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TOTAL AMOUNT OF PAYMENT (\$) 395.

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|----------------------|---------------------|
| Application Number | |
| Filing Date | |
| First Named Inventor | Andrew J. Cleveland |
| Examiner Name | |
| Group / Art Unit | |
| Attorney Docket No. | MLF-600-09 |

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FEE CALCULATION

1. BASIC FILING FEE

| Large Entity Fee Code | Small Entity Fee Code | Fee Description | Fee Paid |
|--------------------------|--------------------------|------------------------|----------|
| 101 710 | 201 355 | Utility filing fee | 355 |
| 106 320 | 206 160 | Design filing fee | |
| 107 490 | 207 245 | Plant filing fee | |
| 108 710 | 208 355 | Reissue filing fee | |
| 114 150 | 214 75 | Provisional filing fee | |
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2. EXTRA CLAIM FEES

| Total Claims | Extra Claims | Fee from below | Fee Paid |
|--------------------|--------------|----------------|----------|
| 12 | -20** | X | |
| 3 | -3** | X | |
| Multiple Dependent | | | |

**or number previously paid, if greater; For Reissues, see below

| Large Entity Fee Code | Small Entity Fee Code | Fee Description | Fee Paid |
|--------------------------|--------------------------|--|----------|
| 103 18 | 203 9 | Claims in excess of 20 | |
| 102 80 | 202 40 | Independent claims in excess of 3 | |
| 104 270 | 204 135 | Multiple dependent claim, if not paid | |
| 109 80 | 209 40 | ** Reissue independent claims over original patent | |
| 110 18 | 210 9 | ** Reissue claims in excess of 20 and over original patent | |
| SUBTOTAL (2) (\$) | | | 355 |

FEE CALCULATION (continued)

3. ADDITIONAL FEES

| Large Entity Fee Code | Small Entity Fee Code | Fee Description | Fee Paid |
|--------------------------|--------------------------|--|----------|
| 105 130 | 205 65 | Surcharge - late filing fee or oath | |
| 127 50 | 227 25 | Surcharge - late provisional filing fee or cover sheet | |
| 139 130 | 139 130 | Non-English specification | |
| 147 2,520 | 147 2,520 | For filing a request for reexamination | |
| 112 920* | 112 920* | Requesting publication of SIR prior to Examiner action | |
| 113 1,840* | 113 1,840* | Requesting publication of SIR after Examiner action | |
| 115 110 | 215 55 | Extension for reply within first month | |
| 116 390 | 216 195 | Extension for reply within second month | |
| 117 890 | 217 445 | Extension for reply within third month | |
| 118 1,390 | 218 695 | Extension for reply within fourth month | |
| 128 1,890 | 228 945 | Extension for reply within fifth month | |
| 119 310 | 219 155 | Notice of Appeal | |
| 120 310 | 220 155 | Filing a brief in support of an appeal | |
| 121 270 | 221 135 | Request for oral hearing | |
| 138 1,510 | 138 1,510 | Petition to institute a public use proceeding | |
| 140 110 | 240 55 | Petition to revive - unavoidable | |
| 141 1,240 | 241 620 | Petition to revive - unintentional | |
| 142 1,240 | 242 620 | Utility issue fee (or reissue) | |
| 143 440 | 243 220 | Design issue fee | |
| 144 600 | 244 300 | Plant issue fee | |
| 122 130 | 122 130 | Petitions to the Commissioner | |
| 123 50 | 123 50 | Petitions related to provisional applications | |
| 126 240 | 126 240 | Submission of Information Disclosure Stmt | |
| 581 40 | 581 40 | Recording each patent assignment per property (times number of properties) | 40. |
| 146 710 | 246 355 | Filing a submission after final rejection (37 CFR 1.129(a)) | |
| 149 710 | 249 355 | For each additional invention to be examined (37 CFR 1.129(b)) | |

Other fee (specify) _____

Other fee (specify) _____

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$)

395.

SUBMITTED BY

Typed or
Printed Name Richard B. Main

Complete (if applicable)

Reg. Number 33,258

Signature

Date 10/12/2000

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Applicant or Patentee: Andrew J. Cleveland

Serial or Patent No.:

Filed or Issued: attached

For: POWER CONTROLLER WITH DC ARC-SUPPRESSION RELAYS

Attorney: Richard B. Main, Reg. No.: 33,258

Attorney's Docket No.: MLF-600-09

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL
ENTITY STATUS 37 CFR 1.9(f) and 1.27(c) - INDEPENDENT INVENTOR**

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled:

POWER CONTROLLER WITH DC ARC-SUPPRESSION RELAYS

described in:

☒

the specification filed herewith

☐

application serial no.:

filed:

☐

patent no.:

issued :

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

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no such person, concern, or organization

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persons, concerns or organizations listed below*:

*Note: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME/ADDRESS:

☐

individual

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small business concern

☐

nonprofit organization

NAME/ADDRESS:

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I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the same time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is direct.

Name of inventor: Andrew J. CLEVELAND, USA citizen

Address: 5419 Greenview Court, Reno, NV 89502

Inventor's signature:

Andrew J. Cleveland

Date: 10/05/2000

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Your petitioner, Andrew J. CLEVELAND, a citizen of the
United States and a resident of Reno, Nevada, and whose post
5 office address is 5419 Greenview Court, Reno, NV 89502, prays
that letters patent may be granted to him for a

POWER CONTROLLER WITH DC ARC-SUPPRESSION RELAYS

10 set forth in the following specification.

036947-10100

access multiplexers are now available from a number of different manufacturers, e.g., Paradyne, Copper Mountain, Ascend, etc.

Nearly all such digital subscriber line access
5 multiplexers are powered by 48-VDC battery power and all have operator console ports. And for emergencies, these DSLAMs usually have two independent 48-VDC battery power supplies, e.g., an A-channel and a B-channel. Most commercial DSLAMs are also controlled by large operating systems that host
10 various application software. Unfortunately, this means most DSLAMs have the potential to fail or lock-up, e.g., due to some software bug.

When a digital subscriber line access multiplexer does lock-up, the time-honored method of recovering is to cycle
15 the power, i.e., reboot. But when a digital subscriber line access multiplexer is located at a telco central office, such location practically prevents it being easy to reboot manually.

There are many large router and ATM switch farms around
20 the country that are equipped by the leading vendors, e.g., Cisco, Bay Networks/Nortel, Ascend, Lucent, Fore, etc. So each of these too has the potential to lock-up and need rebooting, and each of these is very inconvenient to staff or visit for a manual reboot when needed.

25 Server Technology, Inc., (Sunnyvale, CA) markets a 48-VDC remote power manager and intelligent power distribution unit that provides for remote rebooting of remote digital subscriber line access multiplexers and other network equipment in telco central offices and router farms. The
30 SENTRY 48-VDC is a network management center that eliminates the dispatching of field service technicians to cycle power

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and rectify locked-up digital subscriber line access multiplexers.

Statistics show that seventy percent, or more, of all network equipment lock-ups can be overcome by rebooting, e.g., cycling power off and on. A remote power controller, like the SENTRY, can reduce network outages from hours to minutes.

In a typical installation, the telco central office provides the competitive local exchange carriers with bare rack space and a 48-VDC power feed cable that can supply 60-100 amps. The single power input is conventionally distributed through a fuse panel to several digital subscriber line access multiplexers in a RETMA-type equipment rack. Individual fuses in such fuse panel are used to protect each DSLAM from power faults.

But such fuses frequently weld themselves to their sockets in the fuse panel due to loose contacts and high amperage currents. It is ironic therefore that many digital subscriber line access multiplexers do not have power on/off switches. Thus it requires the fuse to be pried out and put back in so the DSLAM can be powered-off for rebooting. But when the fuse is welded, removing the fuse without damaging the fuse panel can be nearly impossible.

The Server Technology SENTRY 48-VDC accepts from the telco or other site host an A-power feed cable and B-power feed cable. Internally, DC-power is distributed to a set of "A" and "B" rear apron output terminal blocks that are protected by push-to-reset circuit breakers. The fuse panel is no longer required. The A-feed and B-feed are then matched to the newer digital subscriber line access multiplexers that also require A-power supply and B-power supply inputs.

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same physical phenomena that welds the fuses in their holders can also weld or destroy the contacts of these relays.

Most electric welders generate the high heats necessary to fuse metal together by arcing a direct current (DC) low
5 voltage (under 50-volts) and high current (over 50-amps) across an electrode gap. Such conditions occur in a power controller's relay, especially when the relay contacts are opening. The mass inertia of the contact mechanism has to be overcome before the contacts can open. The contacts
10 accelerate apart, but are moving only very slowly at the start. Electric arcs, once generated, will continue even though the electrode separation distance is increased. This is the so-called Jacob's Ladder effect. The ionized air and the heated contacts increase the distance an arc can bridge.
15 The arcing stops only after the contacts are very wide apart.

In contrast, a pair of open relay contacts will not arc until the contacts get very close to one another. By this time, the contact closure is moving at its near maximum velocity. So the remaining gap that needs to be closed up
20 when the arc commences will vanish quickly.

SUMMARY OF THE PRESENT INVENTION

25 It is therefore an object of the present invention to provide a DC arc-suppressor for network appliance power managers.

It is another object of the present invention to provide a power controller with long-lasting and reliable relay
30 operation.

Briefly, a DC arc-suppressor embodiment of the present invention for network appliance power managers comprises an

electromechanical relay that controls the flow of battery power to a network appliance by remote control. The relay includes electrical contacts that open to interrupt the flow of current in response to an off-command signal. A

5 transistor is connected in shunt across the relay contacts to temporarily divert such flow of current. A timing circuit is connected to respond to the off-command signal by first turning on the shunt transistor, then open the relay contacts, then turn off the shunt transistor. Such shunt
10 transistor is sized to carry the full rated power of the relay contacts, but only for the few milliseconds that are needed to allow the relay contacts to fully separate.

An advantage of the present invention is that a DC arc-suppressor is provided for network appliance power managers.

15 Another advantage of the present invention is that a power controller is provided for network appliances.

These and many other objects and advantages of the present invention will no doubt become obvious to those of ordinary skill in the art after having read the following
20 detailed description of the preferred embodiments which are illustrated in the various drawing figures.

25

IN THE DRAWINGS

Fig. 1 is schematic diagram of a power controller embodiment of the present invention that includes a DC arc-suppression circuit;

30 Fig. 2 is a timing diagram related to various signal points in Fig. 1; and

Fig. 3 is a functional block diagram that shows a dual-source battery power manager wired to power-cycle DSLAM, routers, and other network devices.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 illustrates a power controller embodiment of the present invention, referred to herein by the general reference numeral 100. The power controller 100 connects to a computer data network 102, e.g., the Internet, and can send status and receive commands with a network client 104. A power-OFF command raises a signal line 105 and triggers a one-shot multivibrator 106. A twenty millisecond long pulse is fed to an opto-isolator 108 through a dropping resistor 110. This turns-on a power metal-oxide-semiconductor field-effect transistor (MOSFET) 111.

The raising of signal line 105 by the power-OFF command also is fed through a two-millisecond delay circuit 112 and is forwarded to another opto-isolator 114 through a dropping resistor 116. A switch transistor 115 turns-on and energizes an inductive armature 118 in an electro-mechanical relay.

A set of station batteries 120, e.g., a 48-volt bank at a Telco Central Office, are connected through a master switch 122 and a pair of normally closed relay contacts 124 to a load 126. Network routers, bridges, and other computer network equipment are examples of what is represented by load 126. A suppression diode 128 helps control transients that occur across the load during the operation of the relay contacts 124. A sense resistor 130 is useful for the monitoring of load currents with a voltmeter or oscilloscope.

A conventional arc-suppression network comprising a capacitor 132, a resistor 134, and a diode 136, are connected across the relay contacts 124 to help control arcing and contact burning.

5 Fig. 2 illustrates some of the critical signal timing that occurs in power controller 100 during operation. A signal-A 202 corresponds to the output of the network client 104, e.g., signal line 105. A signal-B 204 corresponds to the load output current, as seen as a voltage across sense
10 resistor 130. A signal-C 206 corresponds to the output of the one-shot multivibrator 106. A signal-D 208 corresponds to the output of the delay circuit 112 as seen by the dropping resistor 116.

During operation, at a time t_0 , the power controller 100
15 is energized. At a time t_1 , the network client 104 receives a power-OFF command, and signal-A 202 is raised. This triggers the one-shot multivibrator 106 and causes a twenty millisecond pulse output to appear as signal-C 206. Such turns-on MOSFET power transistor 111. The signal-A 202 being
20 raised also causes signal-D 208 to follow suit, but with a two millisecond delay. Such energizes relay 118 and pulls open contacts 124. The rising-edge delay of two-milliseconds is represented by the slope of signal-D between times t_1 and t_2 . Signal-B 204 automatically falls back at time t_3 . The
25 MOSFET power transistor 111 turns off, having done its job of shunting the load current while the relay contacts were breaking.

At time t_4 , the network client 104 receives a power-ON command, and signal-A 202 is lowered. This causes signal-D
30 208 to drop and the relay contacts 124 close at time t_5 . The one-shot multivibrator 106 is unaffected because it is positive-edge triggered only.

The one-shot multivibrator 106 can be implemented with a National Semiconductor NE555. The opto-isolators 108 and 114 can comprise photo-relays.

Fig. 3 represents a system 300 that includes a dual 100-amp battery source power manager 302 wired to power-cycle two DSLAMs 304 and 305, four routers 306, 307, 308 and 309, and two generic network devices 310 and 311.

The chassis are all mounted in a single RETMA-rack 312. An A-channel power connector 314 and a B-channel power connector 316 on the power manager 302 receive two circuits of 48-volt DC battery power from a telco site. A pair of batteries 318 and 320 represent these sources. A plurality of power control modules 322-329 internal to the power manager 302 are independently controlled from a network connection 330 and can individually control A-channel and B-channel DC-power supplied to each DSLAM 304 and 305, routers 306, 307, 308 and 309, and generic network devices 310 and 311. Such power control modules 322-329 include the DC arc-suppression circuitry of Fig. 1.

When any of the DSLAMs 304 and 305, routers 306, 307, 308 and 309, and generic network devices 310 and 311 need to be remotely rebooted, an appropriate network data is sent to the responsible power control modules 322-329 to cause both A-channel and B-channel DC power to cycle off and on.

Although the present invention has been described in terms of the present embodiment, it is to be understood that the disclosure is not to be interpreted as limiting. Various alterations and modifications will no doubt become apparent to those skilled in the art after having read the above disclosure. Accordingly, it is intended that the appended claims be interpreted as covering all alterations and

IN THE CLAIMS

5 1. A DC-arc suppression circuit, comprising:

 an electro-mechanical relay with a relay contact
providing for direct current (DC) electricity to be
controlled between a power source and an electrical load, and
further comprising an inductive armature to open and close
10 said relay contact;

 a power transistor connected in electrical shunt
with said relay contact and having an input for controlling a
shunt current;

 a timing circuit connected to said inductive
15 armature and said input of the power transistor; and

 a power-control signal input connected to the
timing circuit;

 wherein, when the timing circuit receives a command
from the power-control signal input to interrupt a flow of
20 power from said power source to said electrical load, it
first turns on the power transistor, then opens said relay
contact, and lastly turns off the power transistor.

 2. The DC-arc suppression circuit of claim 1, wherein:

25 when the timing circuit receives a command from the
power-control signal input to close-circuit a flow of power
from said power source to said electrical load, it simply
causes said relay contact to close and does not operate the
power transistor.

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transistor beginning at the arrival of an OFF-command signal at the power-control signal input.

8. A remote power controller, comprising:

- 5 a network client for sending and receiving power status and power control messages over a computer data network;
- an electro-mechanical relay with a relay contact providing for direct current (DC) electricity to be
- 10 controlled between a power source and an electrical load, and further comprising an inductive armature to open and close said relay contact;
- a power transistor connected in electrical shunt with said relay contact and having an input for controlling a
- 15 shunt current;
- a timing circuit connected to receive a decoded power-ON command and a power-OFF command from the network client; and
- wherein, when the timing circuit receives said
- 20 power-OFF command to interrupt a flow of power from said power source to said electrical load, it first turns on the power transistor, then opens said relay contact, and then turns the power transistor back off.

25 9. The remote power controller of claim 8, wherein:

- when the timing circuit receives a command from the power-control signal input to close-circuit a flow of power from said power source to said electrical load, it simply causes said relay contact to close and does not operate the
- 30 power transistor.

10. The remote power controller of claim 8, wherein:
the power transistor is a MOSFET-type with its
drain and source electrodes connected in parallel to said
relay contact.

5

11. The remote power controller of claim 8, wherein:
the power transistor is a MOSFET-type with its
drain and source electrodes connected in parallel to said
relay contact; and

10 the timing circuit is such that it includes a
switch transistor to electrically control said inductive
armature, and it provides about a two millisecond delay
between a signal at the power-control signal input and its
resulting operation of the relay, and it further provides
15 about a twenty millisecond long switch-ON pulse to the power
transistor beginning at the arrival of an OFF-command signal
at the power-control signal input.

12. A method for reducing the arcing of relay contacts
20 carrying direct current electrical flows, the method
comprising the steps of:

shunting a current around a pair of contacts in an
electro-mechanical relay through a solid-state semiconductor
device to clamp the open-circuit voltage across said pair of
25 contacts under load;

opening said pair of contacts in said electro-
mechanical relay; and

turning off said solid-state semiconductor device
to unclamp the open-circuit voltage across said pair of
30 contacts under load;

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wherein, any tendency of said pair of contacts in said electro-mechanical relay to arc when being opened is suppressed.

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A DC arc-suppressor for network appliance power managers comprises an electromechanical relay that controls the flow of battery power to a network appliance by remote control. The relay includes electrical contacts that open to interrupt the flow of current in response to an off-command signal. A transistor is connected in shunt across the relay contacts to temporarily divert such flow of current. A timing circuit is connected to respond to the off-command signal by first turning on the shunt transistor, then open the relay contacts, then turn off the shunt transistor. Such shunt transistor is sized to carry the full rated power of the relay contacts, but only for the few milliseconds that are needed to allow the relay contacts to fully separate.

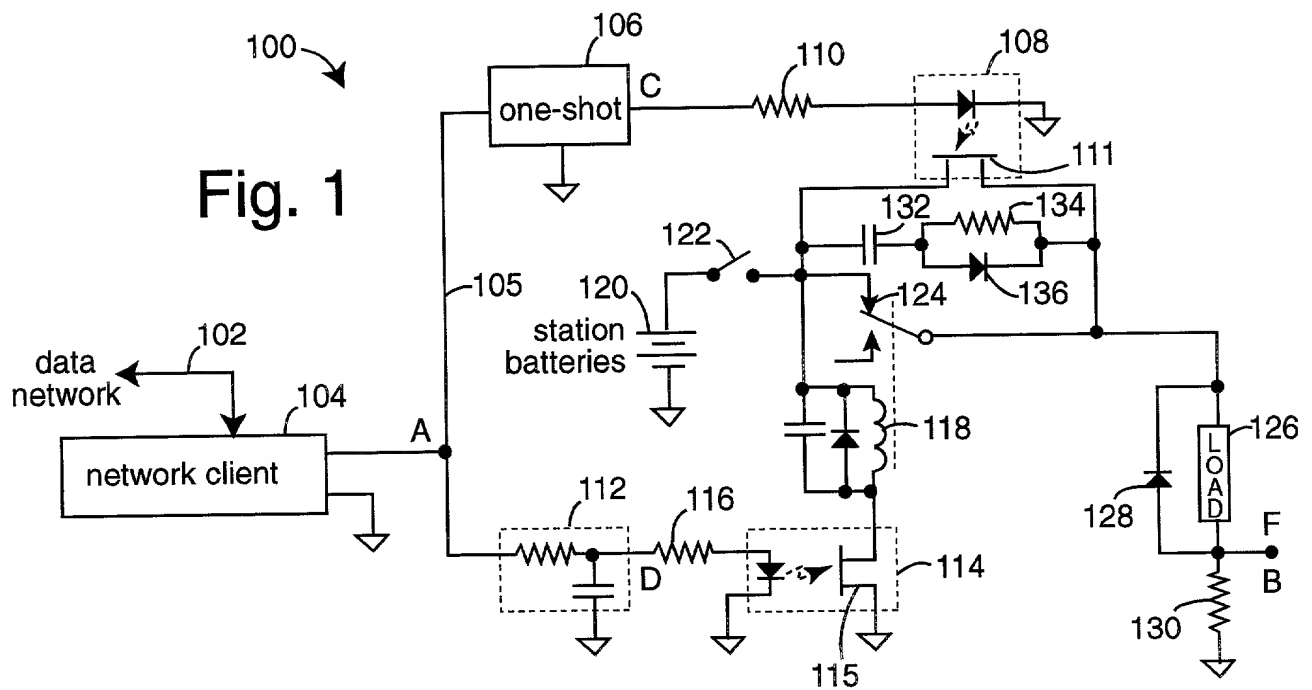


Fig. 2

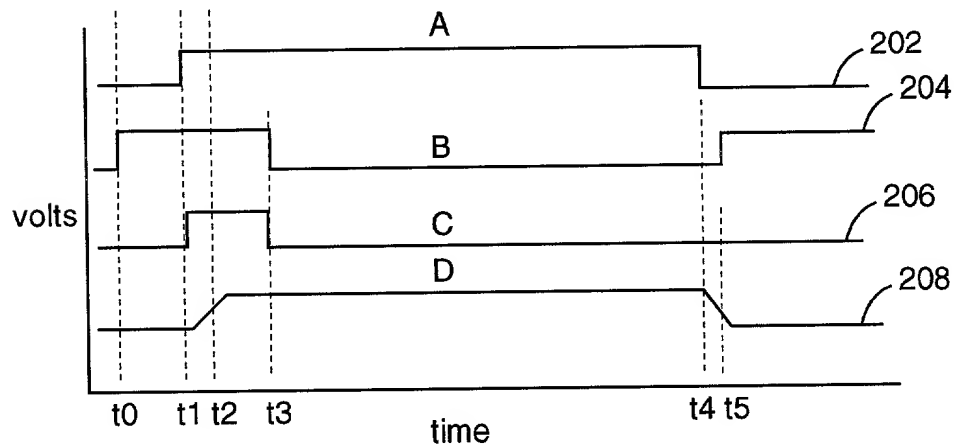
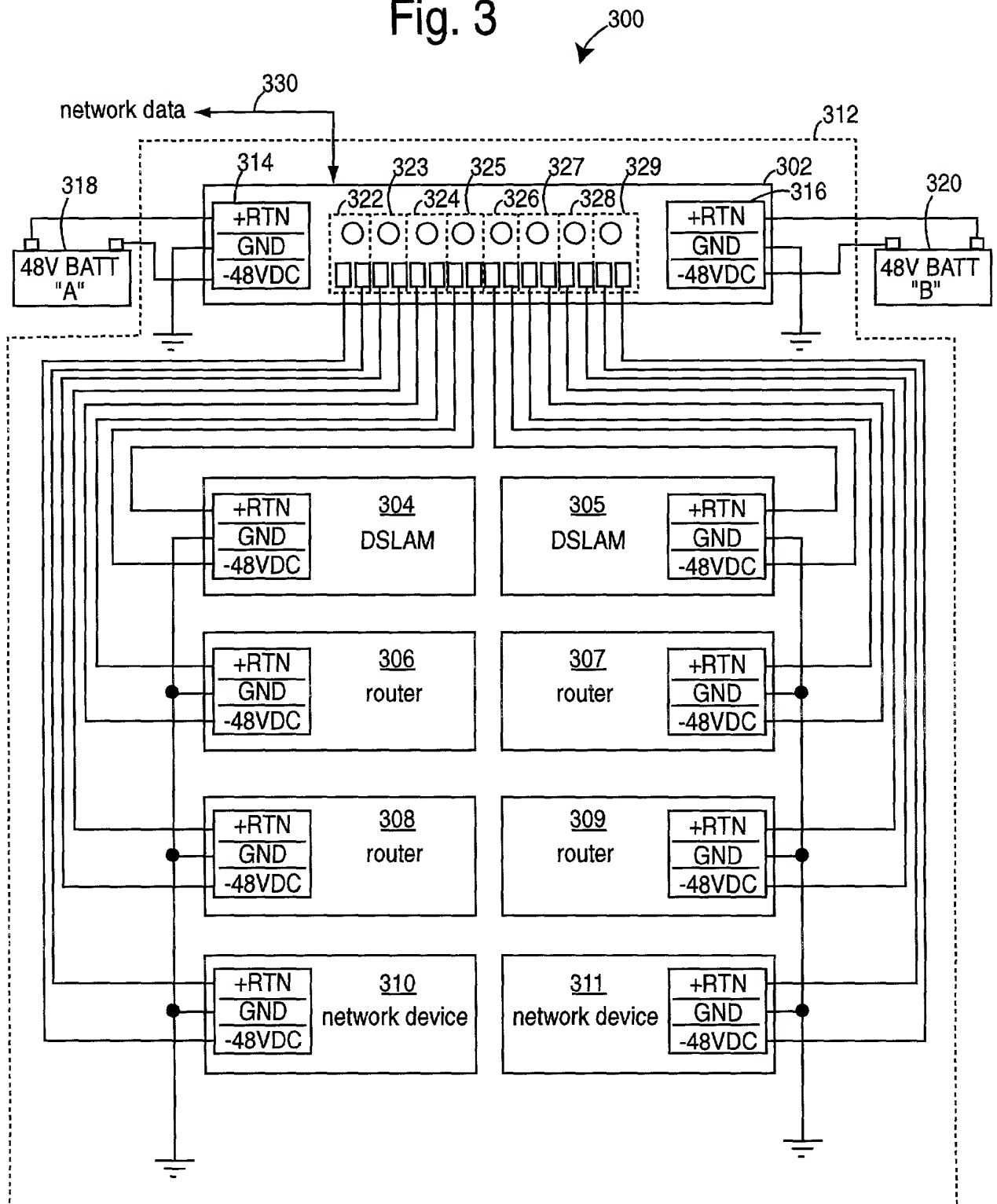


Fig. 3



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Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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| | | |
|---|-------------------------------|--|
| DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63) | Attorney Docket Number | MLF-600-09 |
| | First Named Inventor | Andrew J. CLEVELAND |
| | COMPLETE IF KNOWN | |
| | Application Number | / |
| | Filing Date | |
| | Group Art Unit | |
| <input checked="" type="checkbox"/> Declaration Submitted with Initial Filing | OR | <input type="checkbox"/> Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required) |
| | Examiner Name | |

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

POWER CONTROLLER WITH DC ARC-SUPPRESSION RELAYS

the specification of which (Title of the Invention)

☒ is attached hereto
OR

☐ was filed on (MM/DD/YYYY) [] as United States Application Number or PCT International

Application Number [] and was amended on (MM/DD/YYYY) [] (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

| Prior Foreign Application Number(s) | Country | Foreign Filing Date (MM/DD/YYYY) | Priority Not Claimed | Certified Copy Attached? | |
|--|---------|-------------------------------------|--------------------------|--------------------------|--------------------------|
| | | | | YES | NO |
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☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

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|-----------------------|--------------------------|--|
| 60/224,387 | 08/09/2000 | |

[Page 1 of 2]

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| Richard B. Main | 33,258 | | |

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Direct all correspondence to: ☐ Customer Number or Bar Code Label ☒ Correspondence address below

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

| | | | | | | | |
|--|----------------------------|------------------------|----|---------|------------|-------------|-----|
| Given Name (first and middle (if any)) | | Family Name or Surname | | | | | |
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☒ Additional inventors are being named on the supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto